Evaluating changes in murine fetal brain vasculature due to maternal nicotine exposure using *in utero* optical coherence tomography

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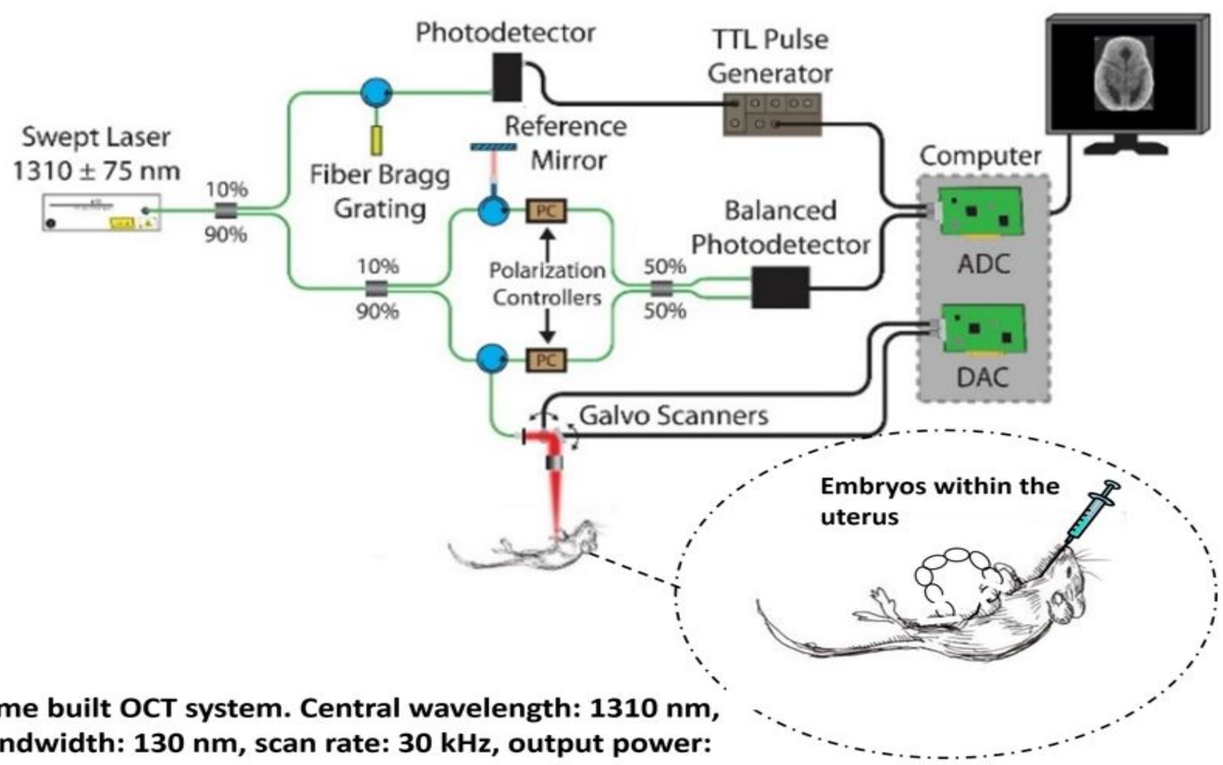
Introduction

- Prenatal substance abuse is a common cause of birth defects in the USA. [1]
- Birth defect severity depends on the substance, amount used, and the period of gestation during which the abuse happened.
- Many woman continue substance abuse into their second trimester of pregnancy, a critical time for brain development.
- Research has shown that prenatal nicotine exposure is harmful to a developing fetus. [2]
- Maternal cigarette smoking is a risk factor for intrauterine growth restriction, perinatal morbidity and mortality, and postnatal growth. [2]
- Optical Coherence Tomography (OCT) is an optical imaging modality, well-suited for murine embryonic imaging. [3]
- Correlation mapping optical coherence angiography (cm-OCA) is a functional extension of OCT used to image microvasculature. [4]
- We use cm-OCA to evaluate vasculature changes in the fetal brain due to prenatal nicotine exposure.

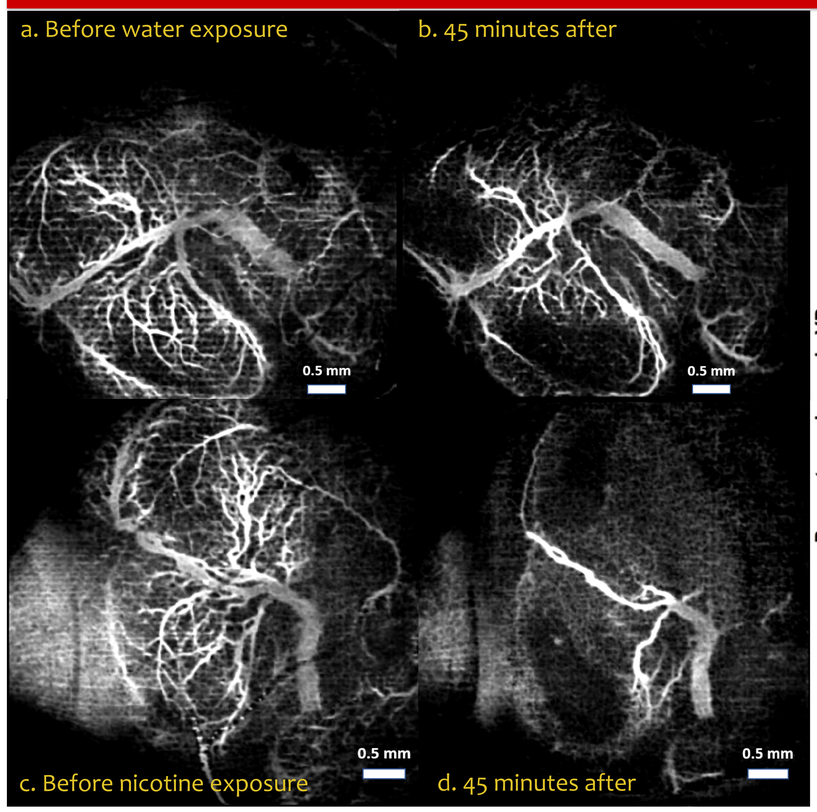
Methodology

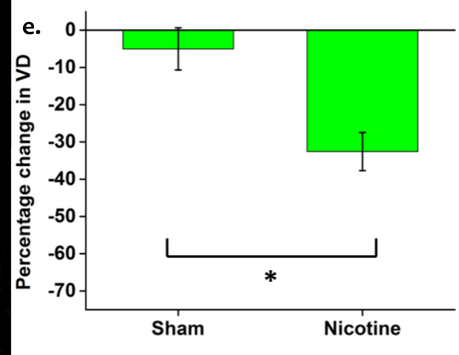
Pregnant mice at embryonic day 14.5 were anesthetized → Mice were weighed, and abdominal fur was removed. The uterus was exposed for imaging. → Pre-nicotine OCT measurements were taken. → The mother was dosed with nicotine (1 mg/kg) via intra-gastric gavage. → OCT measurements were taken over 45 minutes in 5 minute intervals. → cm-OCA processing was performed. After image processing, vasculature parameters were quantified.



Home built OCT system. Central wavelength: 1310 nm, bandwidth: 130 nm, scan rate: 30 kHz, output power: 39 mW, and axial resolution: 11 µm in air.

Results





VD: Vessel Diameter

$n_{nicotine}=5$, $n_{sham}=6$,
$U= 0.3\times10^{-8}$, $P<0.05$

cm-OCA images of murine fetal brain vasculature (a) before and (b) 45 minutes after maternal exposure to water
cm-OCA images of murine fetal brain vasculature (c) before and (d) 45 minutes after maternal exposure to nicotine
(e) Percentage change in vessel diameter (VD) 45 minutes after exposure to water (sham) and nicotine

Conclusions

- cm-OCA can detect the changes in the murine fetal brain vasculature *in utero* after exposure to nicotine
- Results show a significant decrease ($p<0.05$) in vessel diameter 45 minutes after maternal nicotine consumption.
- However, the dose-dependent effects have not been well-studied. Hence, future work will be focused on fetal responses to different doses of nicotine.
- We have already shown the effects of ethanol [5] and cannabinoids [6] on developing fetal brain vasculature. Our future work would also involve evaluating the effects of combined drug abuse.

References

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